


```

=====
ARRAY DIMENSIONS (SEE FILE maxsize.inc)
-----
MAXEL      =      53      Maximum number of elements
MAXCON     =      52      Maximum number of connections
MAXK       =       2      Maximum number of components
MAXEQ      =       3      Maximum number of equations
MAXPH      =       2      Maximum number of phases
MAXB       =       6      Maximum number of phase-dependent secondary variables
MAXSS      =       1      Maximum number of sinks/sources
MAVTAB     =       1      Maximum average number of table entries per sink/source
MAXROC     =       3      Maximum number of rock types
MAXTSP     =       1      Maximum number of specified time steps, divided by eight
MAXLAY     =       1      Maximum number of reservoir layers for wells on deliverability
MXRPCP     =       7      Maximum number of parameters for relative permeability and capillary pressure functions
MXPCTB     =       1      Maximum number of points in table for ECM capillary pressure
MXTBC      =       1      Maximum number of elements with time vs. boundary condition
MXTBCT     =       1      Maximum number of time vs. pressure data
MAXTIM     =      61      Maximum number of calibration times
MAXN       =       3      Maximum number of parameters to be estimated
MAXO       =       2      Maximum number of datasets
MAXM       =     123      Maximum number of calibration points
MAXPD      =     120      Maximum number of paired data
MAXR       =      10      Maximum number of elements or indices of each parameter or observation
MAXBRK     =       1      Maximum number of points in time at which SAVE file is written for restart
MAXEBRK    =       1      Maximum number of elements with new initial conditions after restart
MAXCOEFF   =       1      Maximum number of coefficients for data modeling functions
MAXMOS     =       1      Maximum number of Monte Carlo simulations
MAXCURVE   =       6      Maximum number of curves to be plotted
MAXXGR     =       3      Dimension of third index of array XGUESSR
MTYPE      =      17      Number of observation types
MPFMT      =       6      Number of plot file formats
MAXPV      =       4      Maximum number of primary variables
-----
```

Figure 2.8.3. Excerpt from ITOUGH2 output file *vvRITi.out*, showing information regarding computer system used and command line arguments.

PROGRAM	VERSION	DATE	COMMENT
ITOUGH2	Current version		V3.2 (May 1998)
ITOUGH	1.0	1 AUGUST 1992	ITOUGH User's Guide, Version 1.0, Report NIB 92-99
ITOUGH2	2.2	1 FEBRUARY 1994	ITOUGH2 User's Guide, Version 2.2, Report LBL-34581
ITOUGH2	3.0	12 JULY 1996	YMP Software qualification, Report LBNL-39489
ITOUGH2	3.1	1 APRIL 1997	ITOUGH2 Command Reference, Version 3.1, Report LBNL-40041
ITOUGH2	3.2	1 JULY 1998	YMP Software qualification, Report LBNL-42002
WHATCOM	1.0	10 AUGUST 1993	#35: Q: WHAT COMPUTER IS USED? A: SUN
CALLSIG	1.0	5 DECEMBER 1995	#112: SIGNAL HANDLER
CPUSEC	1.0	10 AUGUST 1993	#--: RETURNS CPU-TIME (VERSION SUN)
OPENFILE	2.5	4 JUNE 1996	#31: OPENS MOST OF THE FILES
LENO5	1.0	1 MARCH 1992	#28: RETURNS LENGTH OF LINE
PREC	1.0	1 AUGUST 1992	#86: CALCULATE MACHINE DEPENDENT CONSTANTS
ITHEADER	3.2	27 MAY 1998	#29: PRINTS ITOUGH2 HEADER
DAYTIM	1.0	10 AUGUST 1993	#32: RETURNS DATE AND TIME (VERSION SUN)
THEADER	3.2	27 MAY 1998	#30: PRINTS TOUGH2 HEADER
INPUT	3.2	20 JUNE 1998	READ ALL DATA PROVIDED THROUGH FILE *INPUT*, + SECONDARY MESH + USERX
CHECKMAX	1.0	11 MAY 1996	#41: CHECK KEY DIMENSIONS
FLOPP	1.0	11 APRIL 1991	CALCULATE NUMBER OF SIGNIFICANT DIGITS FOR FLOATING POINT ARITHMETIC
RFILE	3.2	21 OCTOBER 1997	INITIALIZE DATA FROM FILES *MESH* OR *MINC*, *GENER*, AND *INCON*
ITINPUT	1.0	1 AUGUST 1992	# 2: READS COMMANDS OF COMMAND LEVEL 1
READCOMM	2.5	14 JUNE 1996	#24: READS A COMMAND
FINDKEY	1.1	4 AUGUST 1993	#25: READS A KEYWORD
LTU	1.0	1 AUGUST 1992	#26: CONVERTS LOWER TO UPPER CASE
INPARAME	3.2	20 JUNE 1998	# 3: READS PARAMETERS TO BE ESTIMATED
INPAR	3.1	17 MARCH 1997	# 4: READS PARAMETER VALUES, WEIGHTS, ETC.
INELEM	3.1	3 APRIL 1997	#23: READS GRID BLOCK NAME AFTER A COLON
NEXTWORD	2.5	9 FEBRUARY 1996	#27: EXTRACTS NEXT WORD ON A LINE
INWBP	3.1	17 MARCH 1997	#11: READS WEIGHT, BOUNDS, ANNOTATION, AND PARAMETERS
READREAL	1.0	1 AUGUST 1992	#22: READS A REAL AFTER A COLON
READINT	1.0	1 AUGUST 1992	#21: READS AN INTEGER AFTER A COLON
INOBSERV	3.2	2 OCTOBER 1997	#12: READS TYPE OF OBSERVATION
INTIMES	3.1	29 APRIL 1997	#13: READS TIMES AT WHICH OBSERVATIONS ARE AVAILABLE
INOBS	2.5	13 DECEMBER 1995	#15: READS OBSERVATION INFOS
INOBSDAT	2.5	13 JANUARY 1996	#17: READS ALL OBSERVED DATA
INPAIRED	3.1	2 APRIL 1997	#19: READS PAIRED DATA SET
INWEIGHT	3.2	7 OCTOBER 1997	#20: READS WEIGHTS
INCOMPUT	1.0	1 AUGUST 1992	#16: READS VARIOUS COMPUTATIONAL PARAMETERS
INTOLER	3.1	27 MARCH 1997	#83: READS TOLERANCE/STOPPING CRITERIA
INERROR	2.3	20 DECEMBER 1994	#81: READS COMMANDS FOR ERROR ANALYSIS
INPRINT	2.5	13 JANUARY 1996	#80: READS OUTPUT OPTIONS
GETINDEX	2.2	11 MARCH 1994	#45: GETS INDEX OF ELEMENTS, CONNECTIONS, AND SOURCES
INIGUESS	3.2	20 JUNE 1998	#38: INITIAL GUESS OF PARAMETERS (XGUESS)

Figure 2.8.4. Excerpt from ITOUGH2 output file *vvRITi.out*, showing version control statements.

GETNMAT	2.1	21 SEPTEMBER	1993	#44: IDENTIFIES MATERIAL NUMBER
IXLBXUB	2.1	21 SEPTEMBER	1993	#43: INITIALIZES ARRAY XLB AND XUB
SETWSCAL	2.5	8 AUGUST	1996	#39: INITIALIZES ARRAY WSCALE
OBSMEAN	1.0	1 AUGUST	1992	#40: CALCULATES MEAN OF OBSERVATIONS
SETXSCAL	1.0	1 AUGUST	1992	#42: INITIALIZES ARRAY XSCALE
IN_OUT	3.2	20 JUNE	1998	#35: PRINTS A SUMMARY OF INPUT DATA
TIMEWIND	2.5	30 NOVEMBER	1995	#53: SETS TIME WINDOW
PRSTATUS	3.1	20 FEBRUARY	1997	#91: PRINTS STATUS MESSAGES
ERRORMSG	2.5	21 MARCH	1996	#34: PRINTS ERROR MESSAGES
LEVMAR	2.5	26 MARCH	1996	#99: LEVENBERG-MARQUARDT OPTIMIZATION ALGORITHM
FCNLLEV	2.3	10 JANUARY	1995	#50: RETURNS WEIGHTED RESIDUAL VECTOR
UPDATE	3.2	20 JUNE	1998	#37: UPDATES PARAMETERS
PRIORINF	2.1	21 SEPTEMBER	1993	#48: PRIOR INFORMATION
OBSERVAT	3.2	2 OCTOBER	1997	#62: COMPARES MEASURED AND CALCULATED QUANTITIES
GETMESH	1.1	15 APRIL	1993	#47: READS FILE MESH, MINC, GENER, AND INCON
GETINCON	3.2	18 NOVEMBER	1997	#46: READS FILE INCON
INITTOUG	2.5	18 APRIL	1996	#54: INITIALIZES TOUGH2 RUN (REPLACES CYCIT) *EOS3* ... THERMOPHYSICAL PROPERTIES MODULE FOR WATER/AIR
EOS	1.0	28 MARCH	1991	STEAM TABLE EQUATION: SATURATION PRESSURE AS FUNCTION OF TEMPERATURE
SAT	1.0	22 JANUARY	1990	VISCOSITY OF LIQUID WATER AS FUNCTION OF TEMPERATURE AND PRESSURE
VISW	1.0	22 JANUARY	1990	LIQUID WATER DENSITY AND INT. ENERGY AS FUNCTION OF TEMPERATURE AND PRESSURE
COWAT	1.0	22 JANUARY	1990	CAPILLARY PRESSURE
PCAP	3.2	1 JUNE	1998	VAPOR DENSITY AND INTERNAL ENERGY AS FUNCTION OF TEMPERATURE AND PRESSURE
SUPST	1.0	29 JANUARY	1990	CALCULATE VISCOSITY OF VAPOR-AIR MIXTURES
VISCO	1.0	1 FEBRUARY	1990	COEFFICIENT FOR GAS PHASE VISCOSITY CALCULATION
COVIS	1.0	1 FEBRUARY	1990	VISCOSITY OF VAPOR AS FUNCTION OF TEMPERATURE
VISS	1.0	22 JANUARY	1990	RELATIVE PERMEABILITIES
RELP	3.2	1 JUNE	1998	PERFORM SUMMARY BALANCES FOR VOLUME, MASS, AND ENERGY
BALLA	1.0	5 MARCH	1991	PROVIDE PRINTOUT OF MOST DATA PROVIDED THROUGH FILE *INPUT*
INDATA	1.0	5 MARCH	1991	#55: CALLS TOUGH2 FOR ONE TIME STEP
CALLTOUG	3.1	2 APRIL	1997	ADJUST TIME STEPS TO COINCIDE WITH USER-DEFINED TARGET TIMES
TSTEP	3.1	27 MARCH	1997	ASSEMBLE ALL ACCUMULATION AND FLOW TERMS
MULTI	3.2	1 JUNE	1998	INTERFACE FOR LINEAR EQUATION SOLVERS
LINEQ	0.91 CG	31 JANUARY	1994	CAN CALL MA28 OR A PACKAGE OF CONJUGATE GRADIENT SOLVERS
				UPDATE PRIMARY VARIABLES AFTER CONVERGENCE IS ACHIEVED
CONVER	2.5	13 JUNE	1996	PRINT RESULTS FOR ELEMENTS, CONNECTIONS, AND SINKS/SOURCES
OUT	2.5	18 APRIL	1996	#78: RETURNS OBSERVED DATA AS A FUNCTION OF TIME
OBSERVED	2.4	4 AUGUST	1996	#49: COMPUTE OBJECTIVE FUNCTION
OBJFUN	2.5	21 MARCH	1996	#56: WRITE BEST FIT PARAMETER SET AND BLOCK ROCKS
WRITEPAR	1.0	17 JUNE	1996	#58: WRITES PLOTFILE IN PLOPO-FORMAT
PLOTFILE	3.2	6 OCTOBER	1997	#51: CALCULATES FINITE DIFFERENCE JACOBIAN
JAC	3.1	24 FEBRUARY	1997	#67: ESTIMATES NEW LAMBDA'S
MLLAMBDA	2.2	14 FEBRUARY	1994	#61: PERFORM ERROR ANALYSIS AND TERMINATE ITOUGH2
TERMINAT	3.2	13 MAY	1998	AT THE COMPLETION OF A TOUGH2 RUN, WRITE PRIMARY VARIABLES ON FILE *SAVE*
WRIFI	2.5	13 JANUARY	1996	#77: RETURNS QUANTILE OF F-DISTRIBUTION
QFISHER	2.2	16 FEBRUARY	1994	#88: RETURNS CHI-SQUARE QUANTILE
QCHI	1.0	1 AUGUST	1992	#89: EVALUATES POLYNOM

Figure 2.8.4. (cont.) Excerpt from ITOUGH2 output file *vvRITi.out*, showing version control statements.

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EIGEN      3.2      14 AUGUST    1997      #59: PERFORMS EIGENANALYSIS
LOGLIKE    2.1      29 SEPTEMBER 1993      #68: COMPUTE LOG-LIKELIHOOD
QNORMAL    2.5      13 JANUARY   1996      #87: RETURNS QUANTILE OF NORMAL DISTRIBUTION
MOMENT     3.2      23 JULY      1997      #90: MOMENTS OF DISTRIBUTION
SORT       3.1      17 APRIL     1997      #113: SORTS ARRAY
MOMENT     3.1      17 APRIL     1997      #75: LINEAR REGRESSION ANALYSIS
PLOTIF     1.0      15 FEBRUARY   1993      #96: PLOT INTERFACE
REFORMAT   1.1      15 APRIL     1993      #97: REFORMATS PLOT FILES
QUOTES     1.0      15 FEBRUARY   1993      #98: RETURNS TEXT BETWEEN QUOTES
=====
---      2nd ITOUGH2 simulation job completed: 25-Jun-98 10:51 --- CPU time used =      77.82 sec.
---      0 error(s) and 0 warning(s) detected

```

Figure 2.8.4. (cont.) Excerpt from ITOUGH2 output file *vvRITi.out*, showing version control statements.